

Message

From: Lisa Rector [lrector@nescaum.org]
Sent: 8/13/2018 8:45:20 PM
To: Johnson, Steffan [johnson.steffan@epa.gov]
CC: gallen@nescaum.org
Subject: RE: Condensation in the PM sampling trains

Stef, thanks for your thoughtful answers to Ben, much appreciated. Question about the 5G and ASTM methods (#7), 5G was written as a reg-neg without any PM measurement experts on board and based on a method from the late 70's. ASTM also had wood combustion expertise but no M5 or general PM measurement experts review. Just because it's not mentioned, does that mean it's ok? It might not be there because the people who wrote these things now how to operate a wood stove not necessarily measure PM accurately, which I believe has been our frustration. I am not aware of any EPA certified lab that also does non-wood heater PM measurement. Intertek might but it's a different group. My rant for the afternoon, you can hit the delete button now ☺ Happy Monday!

From: Johnson, Steffan <johnson.steffan@epa.gov>
Sent: Monday, August 13, 2018 4:38 PM
To: Alben T. Myren Jr <myren.ben@gmail.com>
Cc: Bob Ferguson <bob@far-consulting-vt.com>; Toney, Mike <Toney.Mike@epa.gov>; Baumgart-Getz, Adam <Baumgart-Getz.Adam@epa.gov>; John Crouch <crouch@hpba.org>; John Ackerly <jackerly@forgreenheat.org>; Lisa Rector <lrector@nescaum.org>; Eric Schaefer <ericsschaefer82@gmail.com>
Subject: RE: Condensation in the PM sampling trains

Ben,

Again, my answers are in-line, in BLUE, below.

Hope the "ambient smoke" isn't smoking you out!

Stef

From: Alben T. Myren Jr [mailto:myren.ben@gmail.com]
Sent: Thursday, August 9, 2018 2:12 PM
To: Johnson, Steffan <johnson.steffan@epa.gov>
Cc: Bob Ferguson <bob@far-consulting-vt.com>; Toney, Mike <Toney.Mike@epa.gov>; Baumgart-Getz, Adam <Baumgart-Getz.Adam@epa.gov>; John Crouch <crouch@hpba.org>; John Ackerly <jackerly@forgreenheat.org>; Lisa Rector <lrector@nescaum.org>; Eric Schaefer <ericsschaefer82@gmail.com>
Subject: Re: Condensation in the PM sampling trains

Stef, et al.,

1. There was no visible indication of water "puddling" or condensation droplets falling on the filters. But in the past we have had filters that were soaking wet with water. I think I emailed Mike once that we had set a new record with a wet filter that weighed 3 or 4 g. So it can happen!! *While this *can* happen, it is not an optimal result as the wet filter allows soluble PM (condensable organic and soluble salts) to be "pulled" through the filter with the water. The more water on the filter the greater the likelihood that soluble organics will pass through to the back filter. If the back filter is also soaked, there is no doubt that the sample is biased low for PM. (Remember, the dilution tunnel is intended to capture TOTAL PM as defined by ambient filtration temperature). Wet filter = poor filtration. Neither ASTM E-2515-11 nor EPA Method 5G address this issue. Perhaps it was initially thought that the "5H" correction would account for this and, perhaps in some*

instances it comes close; though I have my doubts that the correction covers all the 'sins' of a wet filter. The Agency recognizes that such is the current regulatory landscape, and we are looking long and hard at trying to define a better/cleaner way to keep a filter dry, though an RH meter seems to be a step in the right direction, as does increasing the tunnel flow when combined with enlarging ductwork to maintain velocity at about the same rate.

2. To maximize the %OE, we try to keep the CO₂ as high as possible for all DBRs. This is particularly true of stoves equipped with a VcV on the secondary system. It is not uncommon to see CO₂ levels in the 16-18% range during parts of High, Medium and Low tests. Should EPA opt to go to a cord wood PM standard that is based upon units of pollution per units of useful heat output (g/Mj or lbs./ mm Btu Output), this will only reinforce this effort to maximize the %CO₂ and minimize the % excess air (O₂) across all of the burn rates. Which will tend to increase the %RH of the gases leaving the stove's chimney. *High CO₂ is to be expected, especially at max burn. It has long been the goal of combustion engineers to get the most out of their fuel, and that makes good engineering sense. Whatever we resolve to do moving forward has to accept this reality.*
3. The PM catches on the filters were more than double the 5mg you mentioned as a possible threshold for accurate emissions determination. *Excellent, no worries then.*
4. So if we do increase the tunnel flow and therefore increase the dilution ratio for the gases exiting the stack, the %RH in the tunnel should decrease. And hopefully there will be no condensation in the PM sampling apparatus. EUREKA!! This is PLAN A for our next test. *It's always good to have a plan. This works in theory, and may be robust enough to handle some +H₂O in the wood, or hotter high burn.*
5. Will see what the catch turns out to be and adjust the sample flow rate as warranted. *Ok.*
6. Could it be that the sample flow rate itself is part of our problem? We have all seen situations where if you increase the air flow velocity in "high" humidity situations, it can cause condensation to occur. While it seems counter intuitive to a degree, maybe reducing the sample flow would help prevent the condensation. I know that may create issues with the total PM catch, but if there is plenty of catch even when the PM sampling flow rate is reduced, it doesn't matter. *Condensation is going to happen wherever the flue gas reaches the dew point. The goal of speeding up the dilution tunnel flow to lower the RH is to lower the dew point quickly, right after the dilution air is introduced. The remaining time in the tunnel is then available to allow condensable PM to "mature" into a particulate. Aging is part of the process, and varies with "residence time" in the dilution tunnel.*
6. Another possibility would be to lengthen the probe. The condensation always seems to occur at the end of the probe next to the filter inlet and in the filter housing inlet itself. If the condensation is temperature related - and to some degree, it has to be - then a longer probe might see the condensation occur farther away from the filters. We could even put a cyclone in the system well upstream of the filters to collect the condensation. Unwieldy, yes, but if it works, so be it. *I think it unlikely that a longer probe would resolve the problem, as the probe is unheated. All a longer probe would do is allow gas that has not reached the dew point to get closer to the dew point. We should be focused on keeping the dew point below 80 F (the lower bound of filter temperature).*
7. Back to the original base question. Is there data or scientific literature that shows that the moisture we are talking about really does impact the amount of catch? If so, then this is a new concern. Y/N? It certainly is for me. We have been seeing condensation in our M5G filter sets from basically Day 1. I just don't want to spend a lot of time jousting at windmills if this a really non issue. And I have run innumerable EPA M5 particulate tests where there was lots of condensation in the sampling train and the PM catch had a potential organic component. i.e., wet scrubbers on asphalt plants. *I will have to dive into the 5G archives and see if there is anything there about wet filters. Certainly with 5H this was not an issue as there was no dilution tunnel and the filters were heated. That said, if one was conducting an old-school EPA Method 5 test and the filter became wet*

during the test, that test run is invalidated as the filter exit temperature would demonstrate that the filtration conditions were not hot enough. From this perspective it's easy for me to say "wet filter bad", but again, ASTM E-2515-11 and EPA 5G seem to be silent on that point. If I find anything in the archives, I'll let you know.

But we will do the Plan A described above when we do our next cord wood test. We will photograph the filters from the last round of testing and the next round as well for all to see.

Regards,

Ben

On Thu, Aug 9, 2018 at 8:48 AM, Johnson, Steffan <johnson.steffan@epa.gov> wrote:

Dear Ben,

"Making it disappear" is a good goal, yet it's how one gets to that point that is important. Putting a hair dryer on the glass at that point isn't the right way to go, as it may volatilize something that would otherwise land on the filter. From the photos it appears that this is not a case of rainfall in the dilution tunnel (a very good thing to avoid) nor does it appear that you are getting water drops on the filter (just yet). No staining on the filter when dry, correct? What is to be avoided is a filter that shows it once had a liquid puddle, but that is now gone (did it dry off, or get pulled through?).

Bob F. is correct to point to high burn rates...a good indicator of high moisture is high CO₂ in the flue (likely highest at high burn). Keep in mind that water in the flue is not simply free water contained in the fuel, but also water vapor formed through combustion of the fuel's hydrocarbon content.

We would be more in favor of increasing the dilution tunnel rate in an effort to lower RH in the tunnel and finalize post-combustion formation of condensable PM prior to the filter media. The trick there, as you well know, is that when you increase the velocity in the dilution tunnel you decrease the residence time that is crucial for condensable PM to reach "maturity". Another side effect is that you add more diluent to the sample and PM concentration decreases, giving you less measurable mass on the PM filter.

Provided that you are seeing filter mass increases greater than, say 5mg, you should be fine to increase the tunnel velocity and lower that RH. That should keep your filterable masses above 3mg, and provide for reduction of the visible condensation that you are observing. If your filter catch is below 5mg at this time, you will want to increase your sampling rate such that the SCF increase in sample volume matches the SCF % increase in tunnel flow. In this manner you will be targeting the same sample mass, though the total captured mass will continue to vary with test duration.

The sweetened condensed version of this is....it seems prudent to us that you increase your tunnel flow rate to lower RH and if you are worried about good gravimetric detection then increase your sample volume proportional to that dilution air increase.

Please carefully note whether or not any filters appear stained from a moisture droplet that dried off.

Thanks much,

Stef

From: Alben T. Myren Jr [mailto:myren.ben@gmail.com]

Sent: Wednesday, August 8, 2018 8:14 PM

To: Bob Ferguson <bob@far-consulting-vt.com>

Cc: Johnson, Steffan <johnson.steffan@epa.gov>; Toney, Mike <Toney.Mike@epa.gov>; Baumgart-Getz, Adam <Baumgart-Getz.Adam@epa.gov>; John Crouch <crouch@hpba.org>; John Ackerly <jackerly@forgreenheat.org>; Lisa Rector <lrector@nescaum.org>; Eric Schaefer <ericsschaefer82@gmail.com>

Subject: Re: Condensation in the PM sampling trains

All, Is it a major concern? If we could make it disappear, would that be a plus? Ben

On Wed, Aug 8, 2018 at 11:18 AM, Bob Ferguson <bob@far-consulting-vt.com> wrote:

Cold start with high fire is where we are most likely to see condensation. It is just a fact of life when testing. Happens at various tunnel and sample flow rate combinations.

Bob

Sent from my iPhone

> On Aug 8, 2018, at 11:05 AM, Alben T. Myren Jr <myren.ben@gmail.com> wrote:

>

> All, See attached memo. Ben

> <EPA CONDENSATION MEMO 8.7.18.doc>